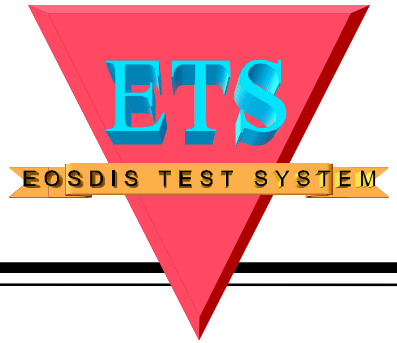


EOSDIS Test System (ETS) for PM-1 Support

Prototype Demo

and

Design Overview

February 24, 1999

Agenda

Introduction	Willie Fuller Estelle Noone
Demonstrations	
PC Prototype for Terra	Bill Parlock / Joe Polesel
Network Test Tool	John Kim
Prototype Conclusions	Estelle Noone
Operations Concept	Estelle Noone
SIMSS/PM-1 Functional Capabilities	Estelle Noone
Simulator Design for PM-1	Kevin Parker
Concluding Material	Estelle Noone
Major Capabilities by Release	
Development Approach	

Introduction

Review Purpose

- To demonstrate the prototype of the PC-based simulator and test tool and to recommend Windows NT PC platform for development of the ETS PM-1 simulator
- To present an overview of the PM-1 simulator design and to receive user feedback to help strengthen the design
- To keep Mission Systems and users informed and involved in the ETS development process

Collaborative Development (1 of 2)

- ETS work funded by Mission Systems as CSOC SODA task (G936)
  - Work includes:
    - » development of PM-1 and future EOS simulators
    - » current support of Terra MPS
    - » upgrade of SCTGEN for PM-1 & beyond
- Separate SOMO-funded SODA task (G903) to enhance our suite of spacecraft simulators and test tools
  - Called Scalable Integrated Multi-mission Simulation Suite (SIMSS)
    - » spacecraft component (SC)
    - » network test tool (NeTT)

Collaborative Development (2 of 2)

- The ETS PM-1 spacecraft simulator
  - Referred to as SIMSS/PM-1
  - Built on the SIMSS architecture and baseline objects
  - ETS developers adding PM-1 specific extensions to simulator and test tool

Rationale for Proof-of-Concept Prototype (1 of 2)

- Concept proposed at SRR/SDR in September to prototype architecture for PM-1 simulator
- Reduce unit cost of simulator making replicated systems possible
- Provide truly portable simulation system
- Build an object-based system that facilitates insertion of new technology and higher fidelity simulation modules as requirements evolve

Rationale for Proof-of-Concept Prototype (2 of 2)

- Incorporate more widely supported commercial products and development tools to
  - enhance productivity
  - increase range of capabilities
  - simplify system configuration and operations
  - provide peripherals like CD ROM
- Exploit use of current technology to provide options for remote access and control
  - Implications for local test support, trouble-shooting at remote locations, and ease of deployment of software updates

Prototype Objectives (1 of 2)

- Functional Objectives
  - Transmit telemetry at required data rates in both IP and serial modes
  - Receive and process spacecraft commands in both IP and serial modes; update command counters and CLCWs
  - Use PDB for telemetry generation and command verification
  - Control timing at milliseconds level
  - Show NT support for UDP/IP multicasting
  - Provide GUI displays and control functions
  - Provide portable on-site test support

Prototype Objectives (2 of 2)

- Performance Objectives
  - Verify that Win / NT is robust enough to support anticipated range of simulator functions
  - Verify that near real-time performance can be maintained on Win / NT
  - Verify that system functions reliably under conditions of stress
  - Verify that system can support long-duration usage
  - Verify that Java can support current user interface requirements

Prototype Results

- Win/NT PC can do the job!
  - Can transmit telemetry at desired rates
  - Can receive in IP and serial modes
  - User interface needs can be met
  - Robust and reliable enough to support full range of activities
- Developers had equal amounts of fun and frustration
  - Lessons learned being documented
  - New development tools and programming languages do enhance productivity
  - There is a learning curve for new operating system and platform
- CORBA will not be used for first release of simulator, but may be considered as a future enhancement

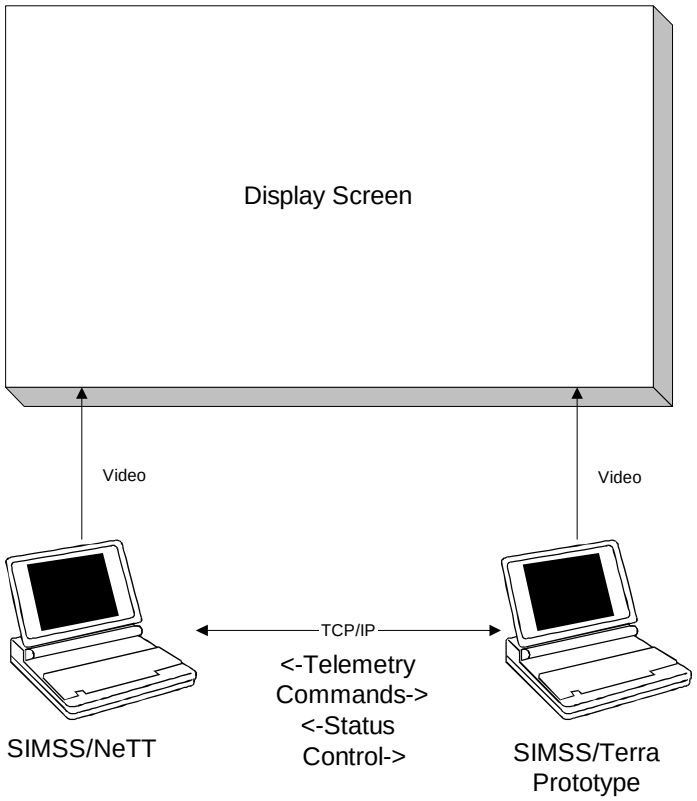
Simulator Prototype Capabilities

- Supports EOS Terra telemetry and command data formats
  - Not a substitute for the MPS, but does provide limited test capabilities
- Transmits two streams of telemetry data in EDOS Sim mode (IP interface) or spacecraft mode (serial data and clock)
  - Generates Housekeeping and Health & Safety formats
- Receives and verifies spacecraft commands in IP or serial mode
- Uses PDB for telemetry generation and command verification
- Provides limited user display and status information

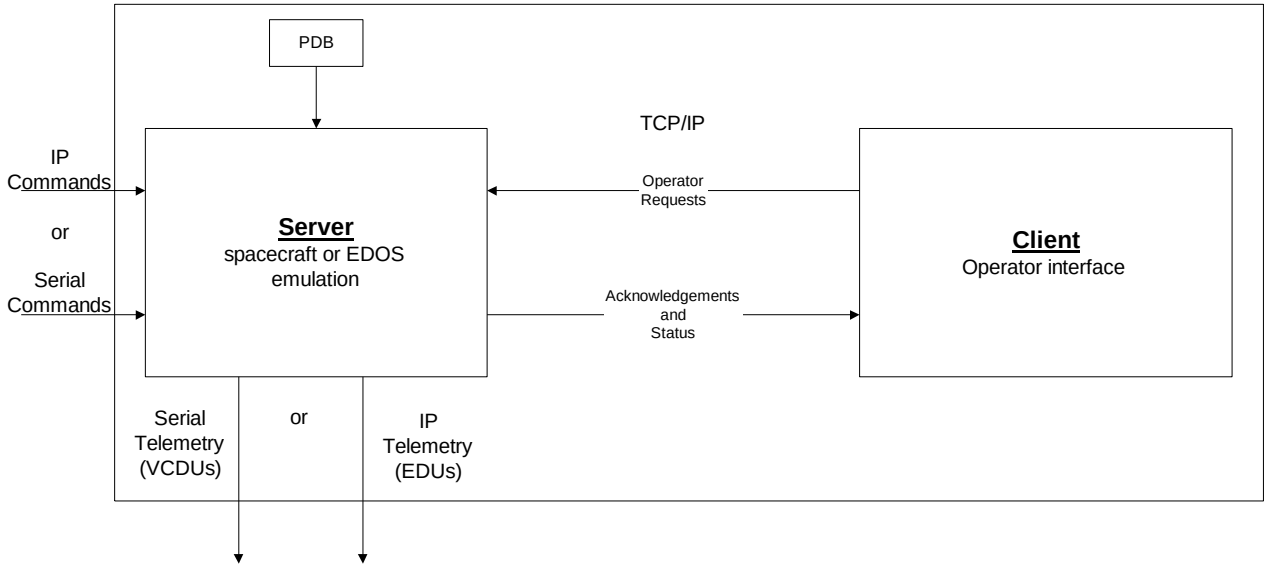
Test Tool Prototype Capabilities

- Transmits test command data to the simulator in IP and serial mode
- Receives telemetry data in IP and serial mode
- Provides limited data quality monitoring (DQM) on received telemetry
- Logs received data

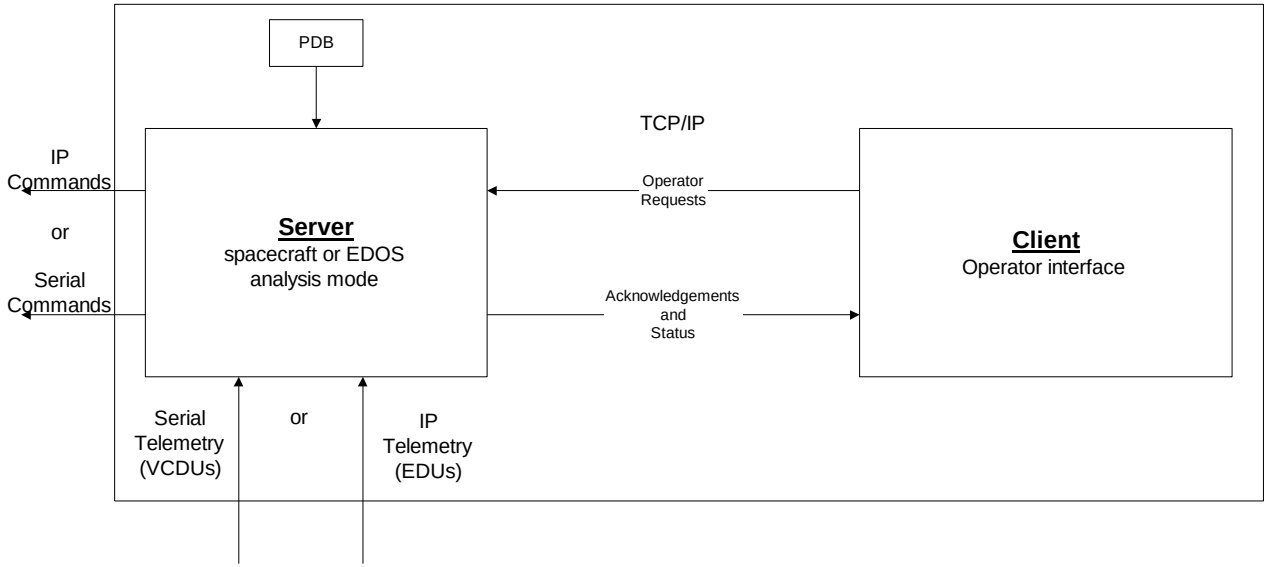
Prototype Configuration



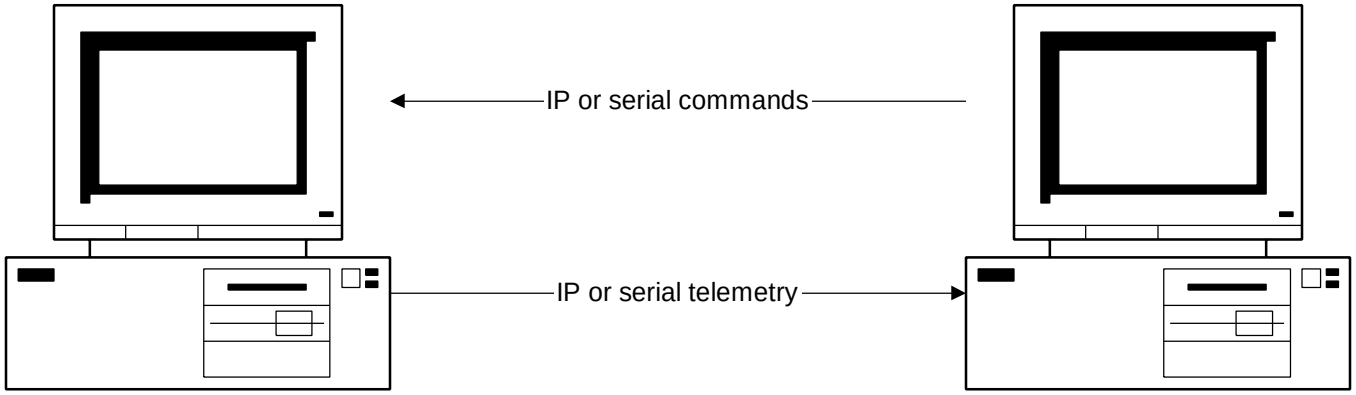
SIMSS/PM-1 Configuration



SIMSS/NeTT Configuration



SIMSS/PM-1 - NeTT Interface



SIMSS/PM-1
Client and Server

SIMSS/NeTT
Client and Server

Demonstrations

PC-based Prototype using Terra Formats
PC-based Network Test Tool

Prototype Conclusions (1 of 2)

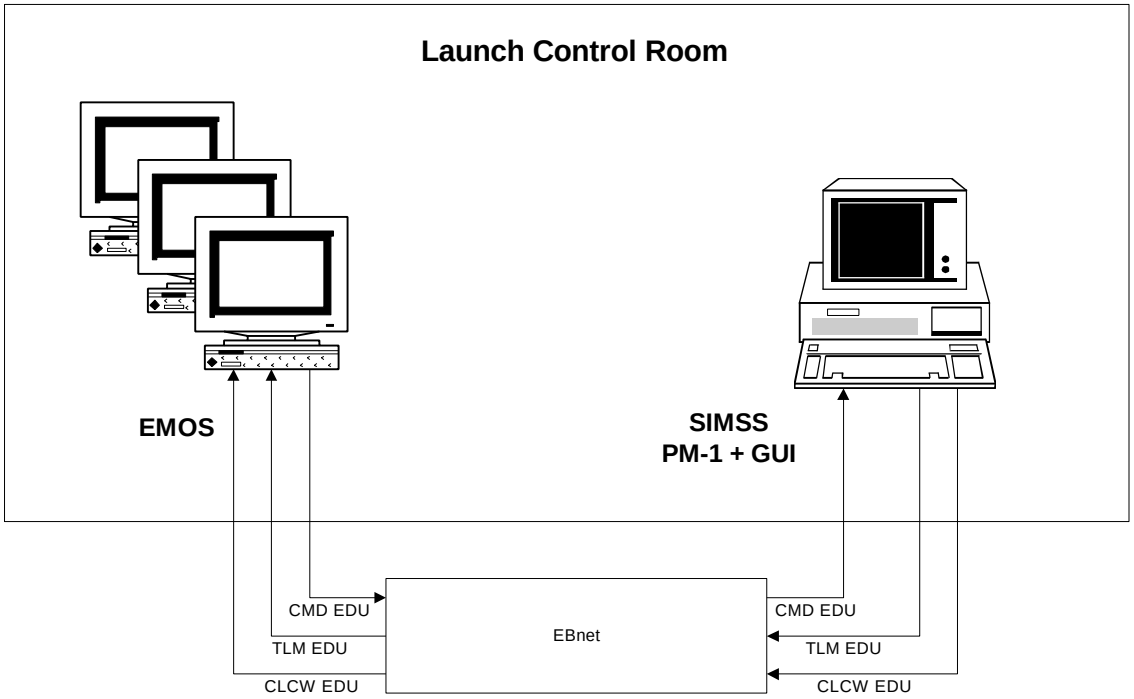
- Selected hardware and software will support our PM-1 simulator requirements
- PCs (even fully loaded) are much less expensive than our MPS VME
- PCs are familiar and easy to operate
  - can also be used to support other day-to-day activities (e.g., email, report writing, test and discrepancy reporting)

Prototype Conclusions (2 of 2)

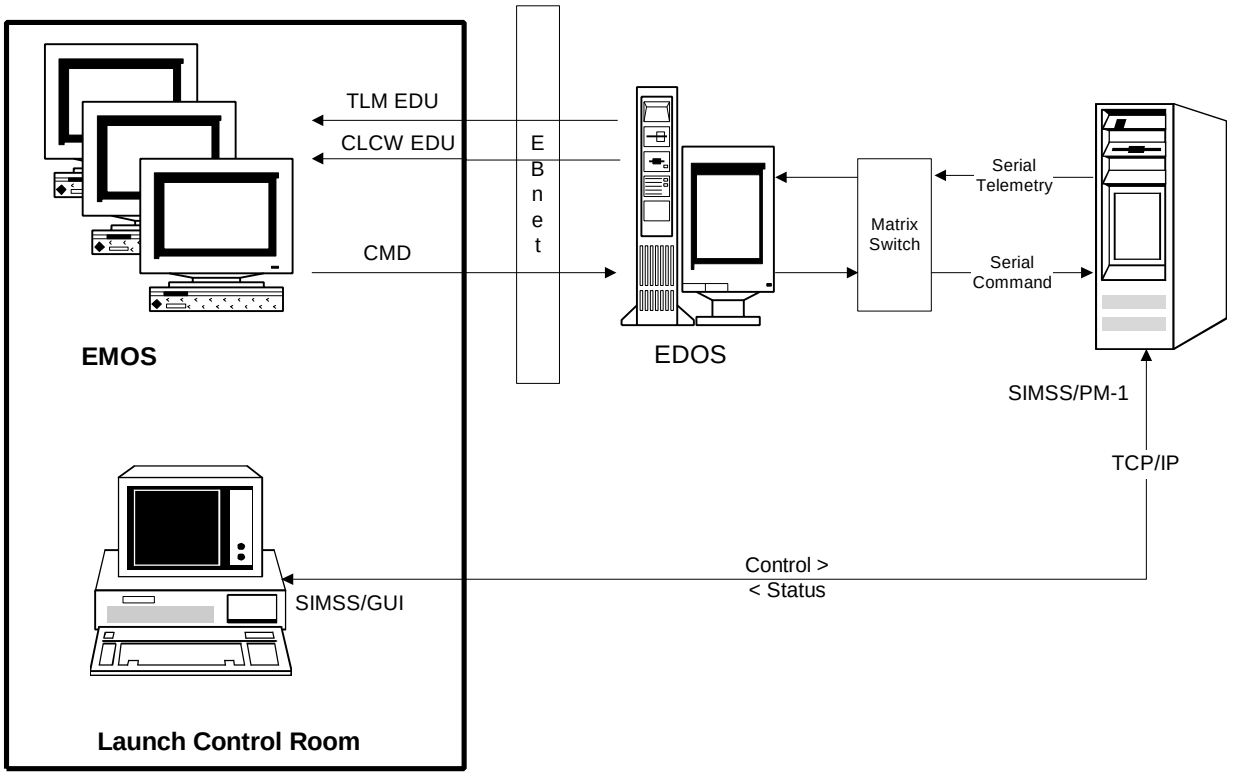
- Integrating simulator with test tool provides a powerful system
  - great for simulator developers
  - will be useful as built-in test function or to augment data capture and analysis functions for users
    - » existing network test tools for developers and testers are very limited
- Selected hardware architecture is portable and versatile
- Added visualization capabilities provide end-user with instantaneous feedback and greater control over processing

Operations Concepts

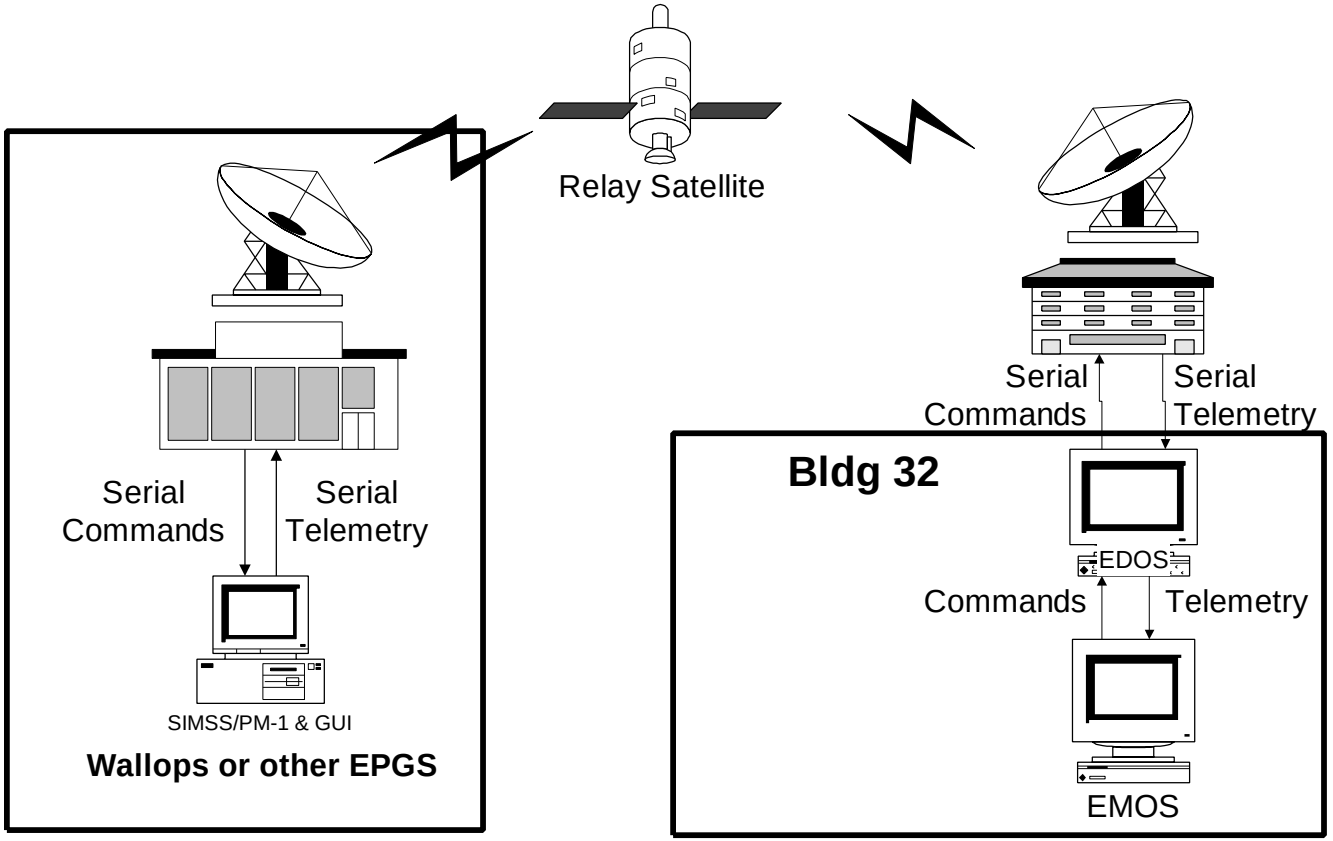
EMOS-Based Testing
(EDOS Sim Mode)



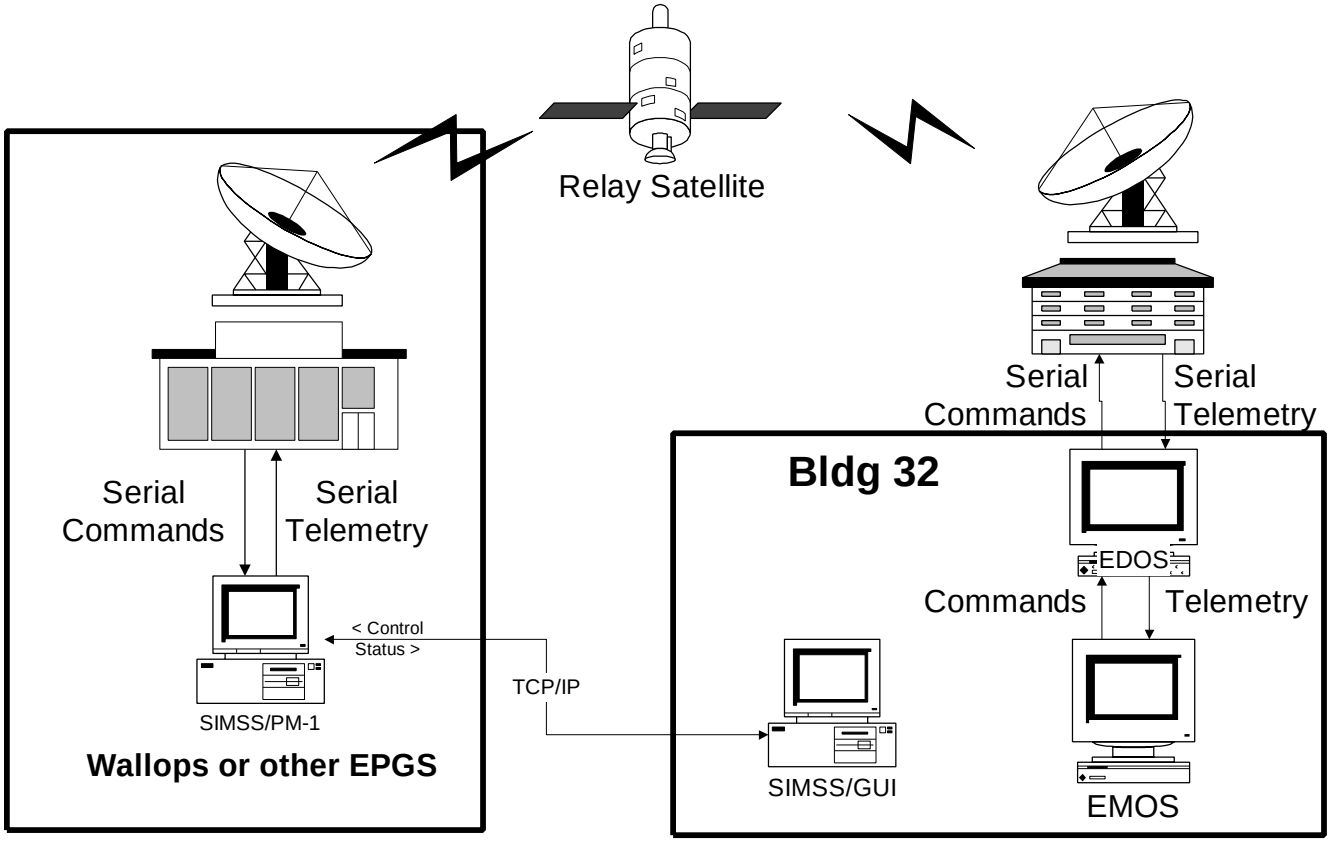
EMOS-Based Testing
(Spacecraft Sim Mode)



EPGS Testing



EPGS Testing
Possible Remote Control Configuration



Implementation Approach

- Windows NT PC is base platform for development
  - Additional drivers needed for different hardware platforms
  - Additional drivers needed for other operating systems
- Ultimate goal is for cross-platform portability
  - Java GUI clients could be hosted on a variety of systems
  - Existing hardware platforms might be reused

SIMSS/PM-1 Functional Capabilities

Functional Capabilities (1 of 5)

- Transmit Telemetry
  - Duplicate PM-1 Data Formats and Rates
  - Inject anomalous data values
  - Control transmission by packet lists and format tables
  - Log telemetry
  - Translate PDB telemetry files
  - Use scenario files
- Receive Commands
  - Validate commands
  - Interpret commands
  - Log commands

Functional Capabilities (2 of 5)

- Receive Commands (continued)
  - Update command counters
  - Update CLCW
  - Update end item verifiers
  - Echo commands
  - Translate PDB command files
  - Process stored commands
  - Execute memory loads and dumps

Functional Capabilities (3 of 5)

- Operator Interface
  - Client - server architecture
  - GUI runs as the client
  - One controlling client
    - » Start / stop telemetry
    - » Enable / disable command validation
    - » Enable / disable logging
  - Ultimately, other clients have monitor capability
    - » monitor commands received
    - » monitor simulator status
    - » view transmitted telemetry

Functional Capabilities (4 of 5)

- Operator Interface (continued)
  - Status Display
    - » Number of EDUs transmitted by channel
    - » Number of commands received
    - » Current simulator configuration
      - Telemetry status (on or off)
      - Command validation status
      - Network status
  - Delog display - telemetry and command
    - » Interpret logged command by mnemonic and contents
    - » Interpret logged telemetry by mnemonic
    - » Interpret block headers

Functional Capabilities (5 of 5)

- Operator Control
  - Start / stop telemetry transmission
  - Enable / disable command validation
  - Switch LANs
  - Enable / disable command and telemetry logging

Test Tool Functional Capabilities (1 of 2)

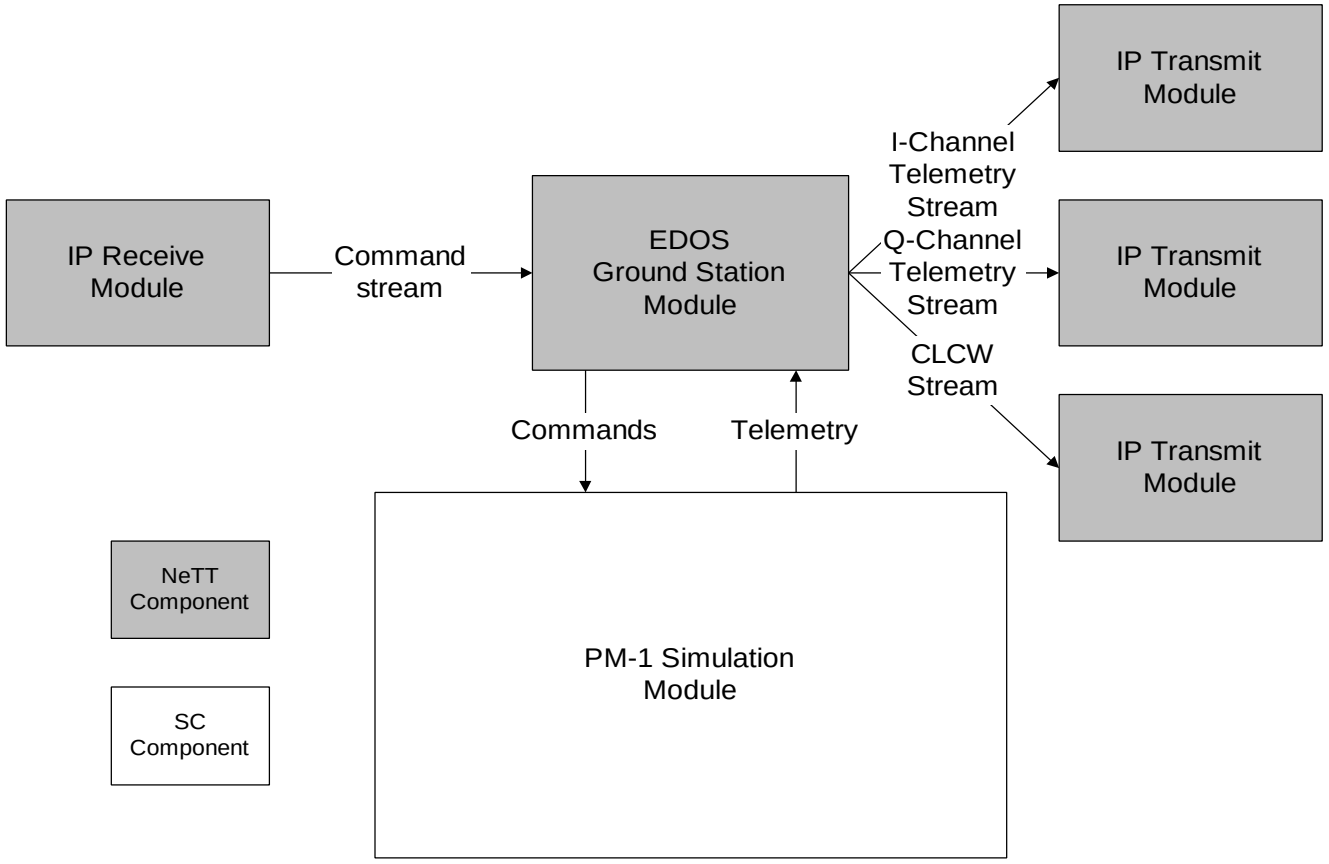
- Transmits test command data to the simulator in IP and serial mode
- Receives telemetry data in IP and serial mode
- Provides limited data quality monitoring (DQM) on received telemetry
- Logs received data

Test Tool Functional Capabilities (2 of 2)

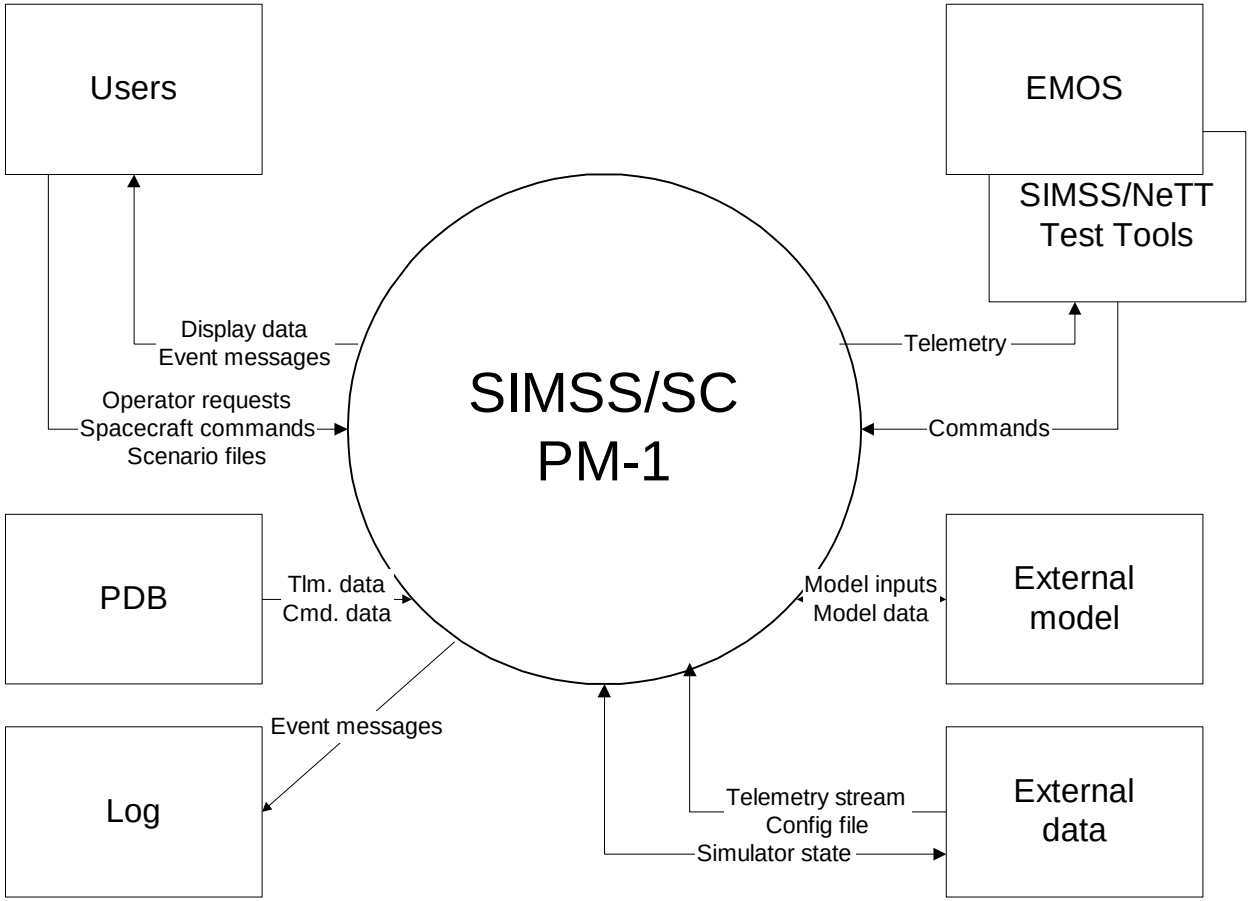
- Delog display - telemetry and commands
  - interpret logged commands by mnemonic and contents
  - interpret logged telemetry by mnemonic
  - interpret EDU, CADU, and packet headers and trailers

Simulator Design for PM-1

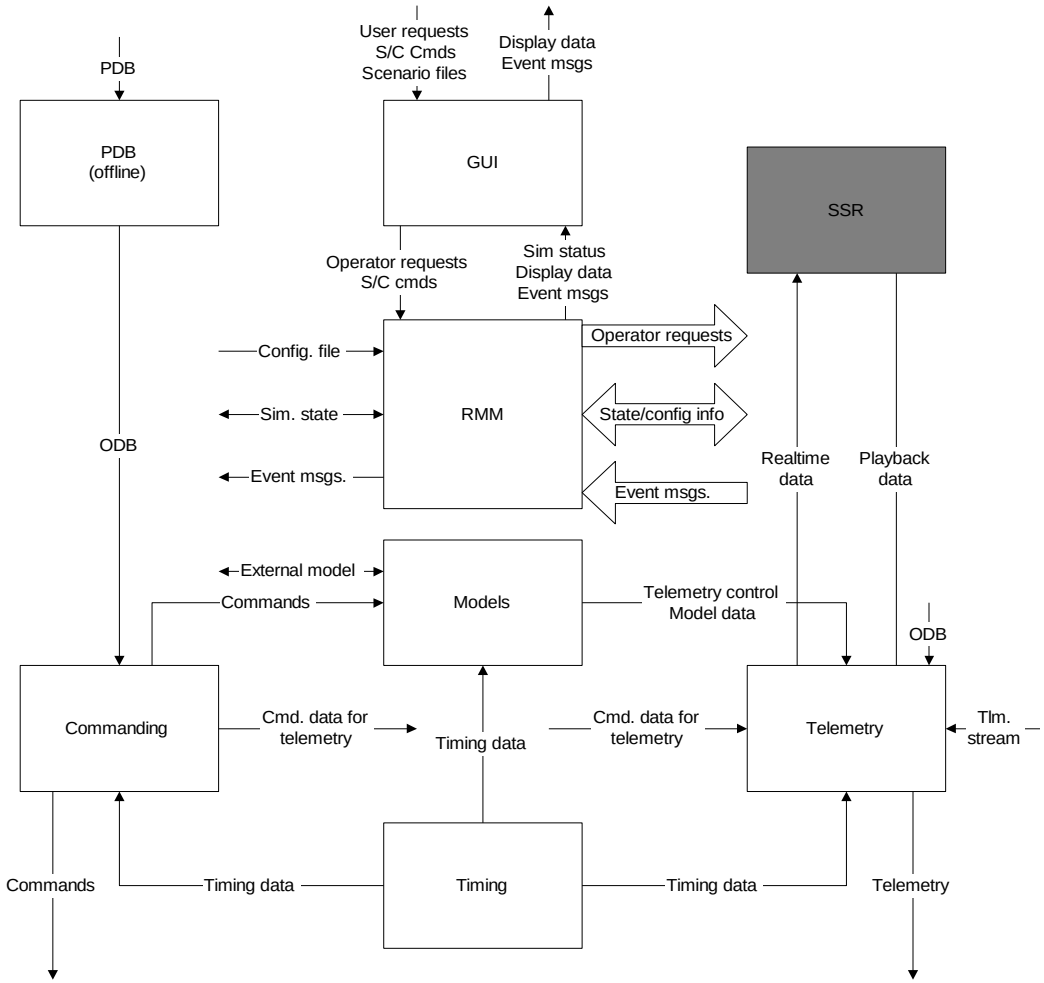
SIMSS/SC-NeTT Interoperability



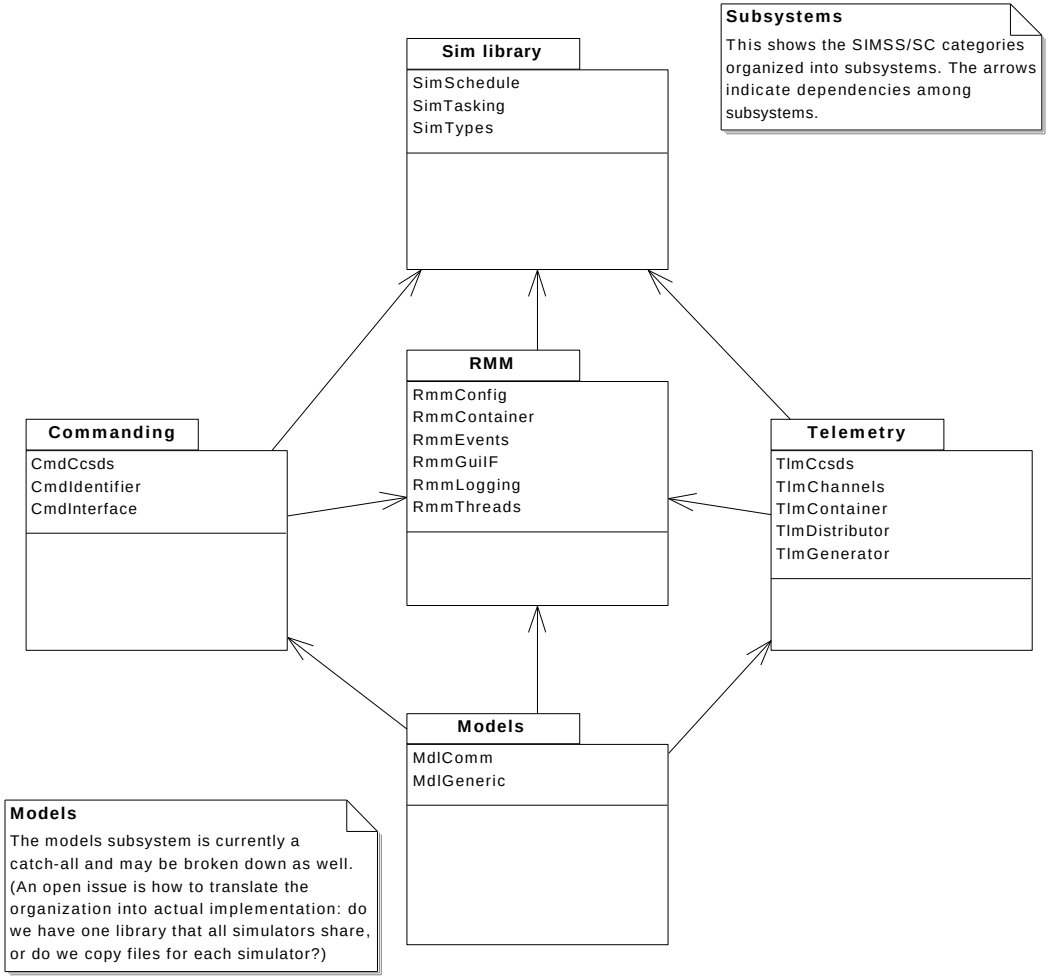
SIMSS/SC PM-1 Context Diagram



SIMSS/SC PM-1 Level 0 Diagram



SIMSS/SC PM-1 Subsystems



Concluding Material

Major Capabilities By Release

- Release 1
  - Telemetry
    - » static data
    - » IP mode, EDU formatted
    - » subset of APIDs
    - » one data rate (4096 bps)
    - » telemetry logging
  - Commanding
    - » command ingest (type AD)
    - » update command counters
    - » update CLCW
    - » command logging

Major Capabilities by Release

- Release 1 (continued)
  - User Interface
    - » start and stop telemetry
    - » display telemetry packets
    - » display commands
    - » display telemetry status
    - » display command status
    - » display simulator event messages
  - Time
    - » maintain spacecraft time
    - » maintain GMT

Major Capabilities by Release

- Release 2
  - Telemetry
    - » multiple data rates
    - » update telemetry points
    - » set values in headers and trailers
    - » translate PDB telemetry
  - Command
    - » update end-item telemetry verifiers
    - » echo commands
    - » translate PDB commands

Major Capabilities by Release

- Release 2 (continued)
  - User Interface
    - » selectable, detailed display of telemetry EDUs and packets
    - » selectable, detailed display of received commands
    - » control of telemetry and command logging
    - » update/change telemetry points
    - » set values in EDU and packet headers and trailers

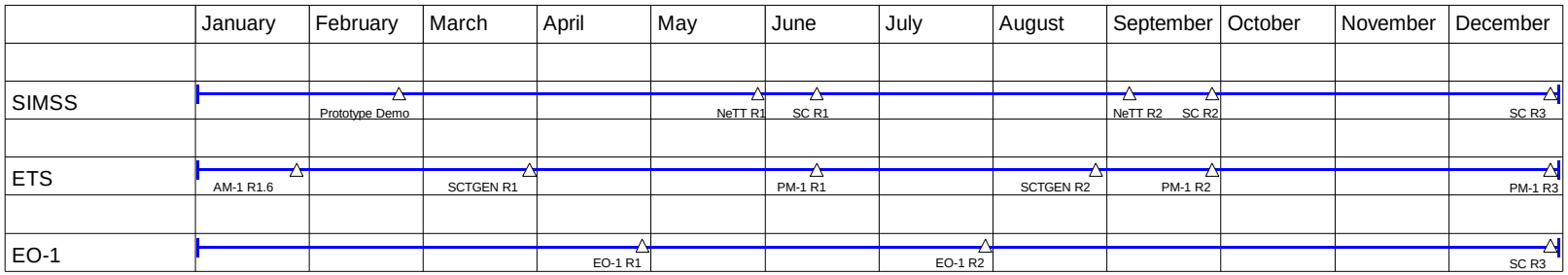
Major Capabilities by Release

- Release 3
  - Telemetry
    - » use scenario files
  - Command
    - » process stored commands
    - » handle memory loads and dumps

Core -Vs- Mission-Specific Capabilities

- Core Capabilities
  - System architecture
  - Generic CCSDS functionality
  - Communications interfaces
  - Operational data base (ODB) interface
- PM-1 Capabilities
  - Spacecraft-specific formatting
  - Spacecraft-specific telemetry generation
  - Offline PDB processing into generic ODB format

Milestone Schedule



- Overlapping implementation and testing phases, where appropriate
- Concurrent SIMSS/SC, SIMSS/NeTT and PM-1 development activities
- Concurrent SCTGEN and PM-1 implementation activities

Effort Estimates

	Core System (DSI)	**PM-1 (DSI)**
Telemetry	0	4900
Commanding	0	2800
GUI	2000	5000
Sim Library	4900	0
RMM	3100	0
Utilities/PDB	0	1000
Total DSI	**10,000**	**13,700**

Other ETS Activities

- Terra Support
  - DR fixes
  - Test support
  - Periodic user training
- SCTGEN Support
  - PM-1 upgrades
  - Terra DRs
  - User training
  - User guide update
- Support for PM-1 Status and Requirements Meetings

Development Approach (1 of 2)

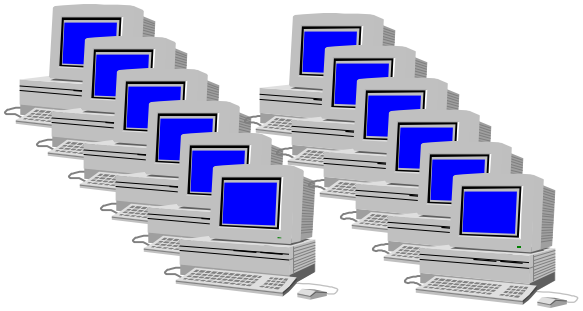
- Team-based rapid application development
  - Spiral refinement of release requirements
  - Overlapping implementation and testing phases
  - Application of “best practice” methodologies
  - Just-in-time technology training
  - Expertise-based mentoring and consultation across the team
  - End-user participation
    - » working group support (e.g., user interface design)
    - » beta testing

Development Approach (2 of 2)

- Leading-edge technology application
  - Object-oriented modular architecture
  - Commercial Off-the-Shelf (COTS) tool integration
  - Integrated Development Environments
    - » Case Design Tools, Development Tools, Configuration Management
      - Examples: Visual C++, Visual Café, Visual Case, StarTeam
  - Use of NeTT to facilitate validation of SIMSS/PM-1
- Overall testing approach that is consistent with MPS testing

Comparison of PC and VME Base Systems Costs

	Windows NT PC	VME
Hardware		
System unit and monitor	**3,800**	**49,420**
Time card	**300-1,500**	**1,730**
Serial I/O card(s) (optional)	**500 – 2,900**	**15,840**
Misc. (adapters, cables, case)	**300**	**710**
Software	**Variable**	**Variable**
Typical 2 Serial I/O card system:	**$ 5,400 – 11,400**	**$ 67,700**



Comparison of PC and VME Base System Costs

- Greater flexibility
- Lower hardware costs
- Ease of scalability - evolve with user needs over time
- Increased reuse
- Expected maintenance cost reduction over time
- Modular design and reusable components will facilitate development of CHEM-1 simulator
  - Concept of one platform supporting different spacecraft simulators, formats, and modules

Needs List and Need Dates

TIE packet definition and critical packet need list	3/1/99
Copy of DFCD	5/1/99
Copy of PDB	5/1/99
Command echo details	5/1/99
Stored command processing details	8/1/99
Memory load and dump details	8/1/99
Additional functionality requests	8/1/99

For More Information

- Request for additional information or clarification should be sent to Mr. Willie Fuller, wfuller@pop500.gsfc.nasa.gov, by March 12
- Contact Estelle Noone
  - enoone@csc.com
  - 301-805-3653
- Visit ETS web site:
  - http://esdis-it.gsfc.nasa.gov/ETS/ets.html
- Visit Simulator Center of Excellence web site:
  - http://cmex.gsfc.nasa.gov

Information Sources

- ICD Between the EOS Common Spacecraft and the EOS Ground System (EGS) October 15, 1998 (TRW)
- EOS Command and Telemetry Handbook for the PM-1 Spacecraft, May 15, 1998 (TRW)
- ICD Between the EDOS and EGS Elements,January 23, 1998, (TRW)
- EOS PM-1 Mission Operations Concept Paper, Preliminary, Revision E,December 8, 1997 (Omitron, Inc.)
- EOS Spacecraft Operations Requirements Document (SORD), May 15, 1998(TRW)
- Project Data Book (PDB),May 15, 1998 (TRW)

Information Sources, continued

- EOS Common Spacecraft C&DHS Requirements Specification, October 30, 1998 (TRW)
- Flight Software User's Guide, July, 1998 (TRW)
- EOS PM-1 Spacecraft Time Management Document, November 13, 1997 (TRW)

Acronyms

AM-1	Morning equatorial crossing spacecraft series
APID	Application Identifier
C&DHS	Command and Data Handling System
CADU	Channel Access Data Unit
CCSDS	Consultative Committee on Space Data Systems
CD-ROM	Compact Disk Read-Only Memory
CLCW	Command Link Control Word
CLTU	Command Link Transmission Unit
CORBA	Common Object Request Broker Architecture
COTS	Commercial, Off-The-Shelf
CSC	Computer Science Corporation
CSOC	Consolidated Space Operation Contract
DFCD	Data Format Control Document
DQM	Data Quality Monitoring
DR	Discrepancy Report
DSI	Delivered Source Instructions
EBnet	EOSDIS Backbone Network
EDOS	EOS Data and Operations System
EDU	EDOS Data Unit
EGS	EOS Ground System
EMOS	EOS Mission Operations System
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information Systems
EPGS	EOS Polar Ground Stations
ETS	EOSDIS Test System
FTP	File Transfer Protocol
GMT	Greenwich Mean Time
GUI	Graphical User Interface
ICD	Interface Control Document
IP	Internet Protocol
LAN	Local Area Network
MPS	Multimode Portable Simulator
MVME	Motorola VME
NT	New Technology
ODB	Operational Database
PC	Personal Computer
PM-1	Afternoon equatorial crossing spacecraft series
PDB	Project Database, Project Data Book
RMM	Realtime Mission Manager
SCTGEN	Simulated CCSDS Telemetry Generator
SDR	System Design Review
SIMSS	Scalable Integrated Multimission Simulation Suite

Acronyms (Continued)

SIMSS/NeTT	Scalable Integrated Multimission Simulation Suite/ Network Test Tool
SIMSS/SC	Scalable Integrated Multimission Simulation Suite/ Spacecraft Component
SODA	Space Operations Directive Agreement
SOMO	Space Operations Management Office
SORD	Spacecraft Operations Requirements Document
SRR	System Requirements Review
SSR	Solid-State Recorder
SWCI	Software Configuration Item
TCP	Transmission Control Protocol
TIE	Transponder Interface Electronics
UDP	User Datagram Protocol
VCDU	Virtual Channel Data Unit
VME	VersaModule Eurocard
Y2K	Year 2000 compliance